Australian Journal of Agricultural Economics, Vol. 39, No. 2 (August 1995), pp 129-141

DEREGULATION AND EFFICIENCY IN GRAIN TRANSPORT

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In this paper, it is argued that removing restrictions on road transport will not be sufficient to encourage efficiency improvements in grain freight industry while rail authorities continue to operate as public monopolies. This is because of the structure of costs in the grain freight industry, which imply that road transport cannot compete with rail transport in areas where road is the more efficient mode. While the tendency for a regulated monopoly to cross-subsidise inefficient operations is common place, the focus in this analysis is on the nature of the cross-subsidy in the grain freight industry, and shows that it is a type of cross-subsidy that is well hidden by aggregation. A model of investment in a rail network is presented where the monopoly power afforded to the rail industry is shown to be due to economies of traffic density. A case study of the grain rail network in Western Australia is presented where it is shown that the rail authority has been able to maintain very uneconomic sections of rail line, despite the introduction of road competition and apparently competitive pricing practices.

Introduction

In the late 1980s a Royal Commission was conducted into the handling, storage and transport of the Australian grain harvest, which looked at the effect of government regulation on the efficiency of the grain distribution system. Studies undertaken during the Royal Commission indicated that large cost savings would be realised in a more competitive environment (Royal Commission into Grain Storage, Handling and Transport 1988a). Savings in transport costs were a large component of the anticipated savings. Following the recommendations of the Royal Commission, Commonwealth and State Governments have taken measures to remove regulation in grain transport. In particular, the restriction on on-road movement of grain have been removed, allowing more competition between the road and rail sectors.

In this study it is argued that road transport cannot compete effectively with rail transport even over sectors where it is the more efficient mode. The nature of competition in the industry is examined by comparing the structure of costs between the two different modes. The economies of traffic density available to the rail industry are highlighted. Results of a case study of some branch lines in Western Australia are presented, where it is shown that inefficient branch lines will continue to be maintained under the competitive freight pricing structures adopted by the rail authority. The efficiency costs of this system are large but could be overcome with alternative institutional arrangements, such as privatisation of the grain rail freight industry.

Railway Pricing Issues

Most studies of grain distribution costs have been based on systems analysis which consider the first best grain paths from farms to the port, based upon resource costs. For example, studies conducted at the time of the Royal Commission compared the grain flows that would minimise resource costs with the grain flows that occurred when historical regulations were present (MacAulay, Batterham and Fisher (1988), Blyth, Noble and Mayers (1987)). This approach was also used by Brennan (1992), and Brindal and Duman (1987) who recommended abandonment of certain branch lines in Western Australia. However, these approaches have failed to take into account the second best pricing practices adopted by the grain freight industry. Faced with incorrect price signals, farmers never make grain delivery decisions that are based on the resource cost of services, so the first best solutions predicted by most modeling work are unattainable.

Second best pricing problems arise because of the nature of costs in the railroad industry. Railroads have large joint costs, which include terminal operating costs and the large cost of maintaining the rail network. Short run marginal cost pricing would lead to losses by the firm, and there is a vast literature on second-best Ramsey pricing rules which enable natural monopolist to recover fixed costs, recouping a larger premium above marginal cost on services that have a more inelastic demand (eg. Sharkey 1982 pp. 48-52).

In a deregulated grain transport environment,[1] a demand based method of rail pricing implies that the prices are determined by the price of the competitive road mode. In fact, pricing practices based on competitive road rates had been adopted in several states even prior to deregulation (Royal Commission into Grain Handling, Storage and Transport 1988b). However, the effect of these pricing practices on rail investment decisions are not well understood. The purpose of this article is to demonstrate the potential for rail authorities to cross-subsidise uneconomic sections of the rail network and to show how easily this cross-subsidisation can be masked from public scrutiny, through the aggregation of services.

The point of departure taken in this paper is the specification of cost structures in the rail industry. There are two sources of costs that are usually treated as fixed costs. One is the fixed costs associated with terminal costs (loading and unloading) which imply that variable per kilometre costs decline as the distance hauled increases (eg. Koo and Uhm 1984). The second is the large cost of constructing and maintain a railway network (eg. Friedlaender and Spady 1980). In the present paper, the fixed

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[1] The term deregulated in this paper refers to the changes in legislation that have removed restrictions on the road haulage of grain, and allow interstate competition of rail services. However, the rail authorities continue to operate as public monopolies.

terminal operating costs are assumed away, in order to focus on line maintenance costs. Line maintenance costs are conventionally treated as fixed costs, but it is argued here that they should be treated as (long run) incremental costs. This long run specification of transport costs allows the appropriate determination of the optimal share of road and rail transport.

In contrast, if we use the traditional concept of variable costs, where the costs of maintaining the network are considered fixed, the cross-subsidies that can be demonstrated by disaggregated analysis are not apparent. This is because rail operating costs are lower than road operating costs for most bulk freight services, except for very short hauls where the fixed cost of loading and unloading rail mean that road is a cheaper alternative. Thus, if rail authorities based their prices on road freight rates in a deregulated system, it would be very difficult to find any evidence of cross-subsidy in the grain freight industry.[2] Prices will always cover incremental rail costs if the incremental costs of maintaining the network are ignored. Indeed, in a recent study by the Western Australian Department of Transport, which used the traditional concept of variable rail costs, it was concluded that all branch lines in Western Australia were viable (Department of Transport 1994). However, this view is based on the erroneous assumption that the fixed costs of the entire rail network are joint costs that should be shared between all users of the network.

In the following, a model of optimal investment in rail infrastructure is presented, in which it is possible to choose alternative modes of transport to complete different sections of the same journey. The rail authority chooses how much track it wants to maintain. It is shown that the net cost of expanding rail network further into the hinterland is increasing at the margin, because of declining traffic density, and this allows road to be more competitive for the low density segments of the journey. With correct specification of the marginal cost of providing freight services, it becomes clear that there is potential for cross-subsidisation in the rail freight industry, based on current pricing practices.

A Model of Optimal Transport Infrastructure

In this simple model, it is assumed that there is a large sparsely populated producing region which produces a commodity which is exported through a single port. The model is designed to determine the optimal size of rail infrastructure and the optimal balance between the rail and road sectors.

The main purpose of this example is to demonstrate the economics of lightly trafficked transport segments, and some simplifying assumptions are made. It is assumed that grain is grown along an axis OP at a density of α t/km, as denoted in Figure 1. Point O is the deepest hinterland, and

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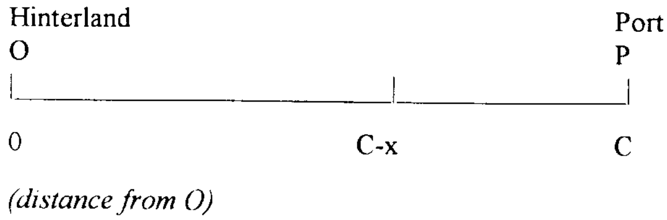
[2] Faulhaber's definition is used here, where prices are considered to be subsidy free provided the price of a service lies between the bounds of incremental and stand alone cost.

P is the port, and the total distance OP is C km. The volume of grain passing over any point y on the axis is αy, where y is the distance from the point 0.

FIGURE 1
The Long Haul Task



Constant variable costs of transport are assumed, where the cost of rail transport is denoted by $\$t$ per tonne kilometre, and the cost of road transport[3] is $\$r$ per tonne-kilometre, and $t < r$. The length of the rail line, constructed from the port towards the hinterland is denoted by x, where $x \leq C$. Rail services are always used where the rail line is available, and grain that is grown beyond the rail line is transported to the rail head by road. The cost of transferring grain from road to rail transport is ignored here, as all grain undergoes this intermodal transfer.

The total annual variable costs of transport are denoted by:

Road transport: $$\int_{0}^{C-x} r\,(ay)\,dy = ra(C-x)^2/2$$

Rail transport: $$\int_{C-x}^{C} t\,(ay)\,dy = ta[C^2-(C-x)^2]/2$$

The fixed costs of rail transport are the costs of constructing and maintaining the rail line, given by \$F per kilometre. There are no fixed costs associated with road transport.

Total annual transport cost is:

$$(1) \qquad T = Fx + a[tC^2 + (r-t)(C-x)^2]/2.$$

First-order conditions gives the socially optimal length of rail track, which minimises total transport costs.

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[3] In this example, the emphasis is on the economics of long hauls and constant variable costs of transport are assumed. In fact, the high fixed operating costs associated with loading and unloading trains make short haul journeys relatively costly compared to road, and mean that road transport is competitive in areas close to the port.

$$(2) \qquad \frac{\partial T}{\partial x} = F - a(r - t)(C - x)$$

Hence optimal rail track length is given by:

$$(3) \qquad x = C - \frac{F}{(r - t)a} \text{ provided } a(r - t)C > F$$

and $x = 0$ otherwise.

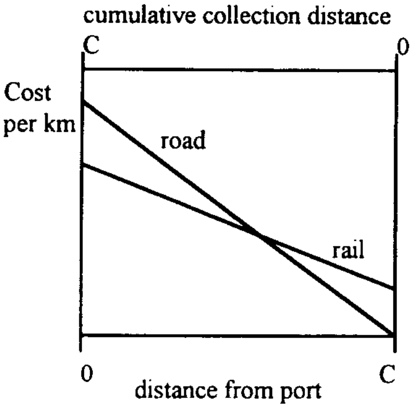
Thus, if track maintenance costs are lower than the marginal excess in operating cost resulting from substituting road for rail for the first unit of rail track, it is worth building some track (ie. $x > 0$). The optimal length of track is inversely related to the ratio of fixed costs per kilometre and the saving in operating costs on the marginal unit of track. Moving from the outer region towards the port, there is a certain amount of haul that must be carried out by road, because the low cumulative density in this area does not justify the fixed costs of rail track. Beyond some minimum collection length (defined by the second right hand side term in Equation 3), the volume of grain collected is high enough to justify the construction of rail track. A longer rail track will be built when the collection area is longer and when fixed costs of maintenance are low. Higher road costs relative to rail, and a higher density of production will also justify a longer rail track.

This representation of costs focuses on the marginal cost of building rail track and can be further demonstrated in Figure 2. In this figure the cost of carrying out the transport task by road and by rail are compared, as a function of distance from the port. The rail cost line shows the marginal cost per kilometre of undertaking the transport task by rail. It is the total transport cost per kilometre that is imposed on the rail authority if it has the responsibility of providing that kilometre of service. It depends on the total volume of grain hauled over that kilometre, and is a declining function of distance from the port because traffic volume decreases. The road transport line shows the marginal cost per kilometre associated with using road transport. These lines are linear in this example because of the assumption that the density of grain production along the line is constant.

The trade-off between road and rail can be seen in this diagram. Starting from the right hand side of he diagram and moving towards the port, per kilometre costs of transport increase because traffic volume increases. When traffic volume are low, the per kilometre cost of rail is higher than the per kilometre cost of road because rail has high fixed costs. As we move closer to the port and accumulate more grain, the per kilometre cost of transport increases at a faster rate for road transport, because per tonne kilometre operating costs are higher. The optimal combination of road and rail transport can be seen from the figure, where rail is the cheaper option closer to the port where traffic volume is higher.

FIGURE 2

Total Cost of Transport over the Marginal Kilometre (moving away from the port)

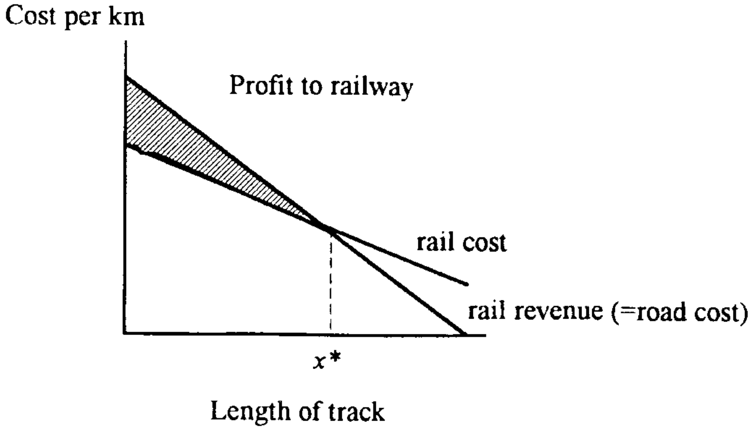


Competitive Pricing

The rail industry has an operating cost advantage over road for the area serviced by the rail line ($t < r$), but it must raise price above operating costs in order to recover fixed costs. The maximum price that the railway can charge is the cost of transporting the grain by road to the port, so rail revenue and road cost are identical. The profit maximising railway makes a profit equal to the area between the marginal revenue and rail cost curves and can be seen on Figure 3. The profit maximising rail authority will choose the socially optimal length of rail track, because they will weigh up the marginal cost of extending the rail service (ie. track length) with the opportunity cost of foregone revenue, which is the marginal cost of road transport. Positive profit occurs because of the cost advantage of rail, which limits contestability in the freight industry.

FIGURE 3

Optimal Track for a Profit Maximising Railway



The Regulated Monopoly

Government railways often operate with non-commercial objectives, for example maintaining a level of service, which can involve disallowing the abandonment of uneconomic branch lines (Harris 1977). Thus, decisions about rail infrastructure are not subject to profit incentives, although regulated monopolies are usually required to satisfy a break even constraint. The length of track chosen by a regulated monopoly will be subject to the break even constraint:

$$(4) \qquad \int_{C-x}^{C} (r-t)(ay)dy - Fx \geq 0.$$

(where revenue collected by the regulated monopoly is $\int_{C-x}^{C} r\,(ay)\,dy$)

This constraint is satisfied as an equality where $x = 2[C - \frac{F}{a(r-t)}]$, which is twice the socially optimal length of track. However, if the socially optimal length is more than half the total collection distance [ie. $\frac{F}{a(r-t)} < \frac{C}{2}$] then the regulated monopoly's rail line covers the entire distance OP, and there is no role for road. In this situation, the regulated monopoly makes a profit if it follows road based pricing.

The expansion of rail track beyond the socially optimal length is shown in Figure 4. Profits made on earlier parts of the journey would cross subsidise the losses made on the lightly trafficked sections and allow the rail authority to compete with road where road was the most efficient alternative.

FIGURE 4a
Rail Monopoly Serves Entire Distance

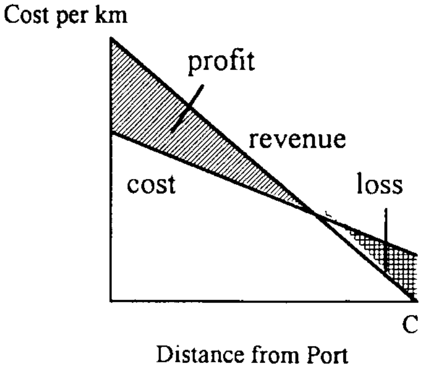
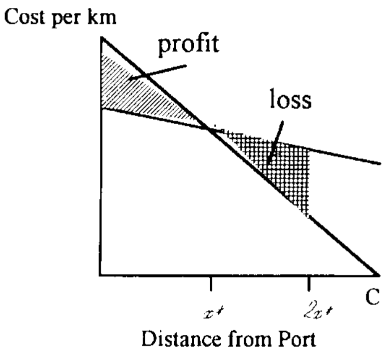


FIGURE 4b

Rail Monopoly Shares Task with Road



Discussion

Joint Costs

In this analysis, it was shown how cost minimising investment decisions on rail track are made. Marginal investment decisions for an extra unit of rail track depend on traffic volume over the marginal unit. Rail is only constructed where it has a cost advantage, and all grain travelling over the region serviced by the rail line is hauled by rail. The volume of grain traffic passing any point on the track is independent of the existence of rail track beyond it (towards the hinterland). The same volume of grain would be flowing through any point on the track regardless of whether the grain was collected from more distant areas by road or rail. Thus the entire length of the rail track should not be considered as a joint cost, and grain originating from points closer to the port have no responsibility for the maintenance of track at more distant sites.

The ability of the rail industry to cross subsidise its operations arises because of spatial monopoly power. It has a captive market for all grain going to the port because it provides the least cost option over the segment of the journey that is adjacent to the port. This means that it can always undercut the road freight industry over this section, and competitive (road based) pricing results in profits that can be used to subsidise inefficient sections. The structure of the industry allows the bundling of inefficient and efficient services and this protects the rail industry from competition in a deregulated environment.

Moreover, the extent of cross-subsidisation in a deregulated environment will not be apparent if analysts continue to treat rail line costs as joint costs. The road transport mode is not competitive over the entire journey, and the correct role for road transport can only be revealed by appropriate disaggregation of rail network costs. This point is illustrated further below, when a case study of the costs of low density branch lines in Western Australia are presented.

Competition from other Rail Companies

This analysis has focused on competition between road and rail. However, Quiggin and Fisher (1977) suggest that since the purchase of mobile capital stock associated with rail transport will have low sunk costs, the operation of rail transport services, given the rail network, is likely to be contestable. Thus in a deregulated system competition could be provided by neighbouring state rail authorities or by private transport companies who own their own rail fleets.

However, the extent to which alternative rail operators can compete with the state rail authority will depend largely on the policy used to price rail network services. If the incumbent rail companies retain ownership of the network, they will retain all price setting power, because of the price they set for rail network services. The limit on the price that can be charged for rail network services is the road rate less the cost of operating trains. Because of the high sunk costs of the rail network, the rival firms could not compete with the rail network, and must pay the charge that the incumbent sets. It is possible that the incumbent will erode efficiency gains by raising the price of network services, or could even price rival firms out of the market.

Branch Line Abandonment in Western Australia

The analytical model presented here has shown the hidden efficiency consequences associated with treating the costs of constructing and maintaining rail network as joint costs to be shared among all users of the network. It was shown that road-rail competition can only be examined effectively by considering rail network investment decisions. In the analytical model, this point was demonstrated using some simplifying assumptions which allowed marginal analysis. In empirical applications of the same issue, it is necessary to take account of the more complex branched structure of the rail network. For example, in a branched network, the density of grain collected along a branch line will be much lower than the density of grain collected along amain line, which receives grain from farms and from other branches. This means that density per tonne kilometre is not a smooth function over an entire length of line from hinterland to the port. In principle, it is better to consider the optimal length of the branch line in isolation. But for a number of empirical reasons, there were *a priori* expectations that optimal branch line length would be zero in the case studies considered here. This is because the per tonne rail operating costs are much higher for branch line services and traffic density is very low in the case study area. Both these factors reduce the profitability of branch line construction (according to Equation 3). Further, the use of the branch line imposes additional intermodal transfer costs in the system examined here, because different gauge tracks are used for the branch and main lines, so grain must be transferred between trains at the main line. For these reasons, the analysis presented here simply considers each branch line as an indivisible unit.

Two low density branch line in Western Australia are considered. The branch lines feed into the standard gauge rail line at Merredin, which is 330 km from the port.

Costs Used in Analysis

The operating costs of transporting grain from each branch line site to Merredin was taken from Brennan (1992). In this study, the costs of rail transport specific to each site were calculated on the basis of estimates of train operating parameters such as train configuration and size, travelling speeds and train loading rates.

The Merredin to Port segment of the journey involves large trains which travel at high speeds, and train operating costs are only $6.20 per tonne for a 330 km journey. This is much lower than the cost of road transport from Merredin to the port (about $20/t). Trains used on the branch line journey have higher operating costs because track characteristics limit train configuration and travelling speeds. Traffic on the branch lines is predominantly grain, and traffic density is low, ranging between 1000t/km and 1500t/km for the different branch lines. In contrast, traffic density on the Merredin to Port journey is higher because this main line carries other freight (it links interstate rail), and because of the cumulative effect of grain traffic which comes from other branch lines and directly from farms.

Road costs used in this analysis were also obtained from the same source, and include the cost of read damage. The issue of road-rail competition is complicated by the external cost of road damage, which implies that the social cost of road transport is not reflected in user charges. The prices set by the rail authority are based on financial costs of road transport, and this means that the monopoly power afforded to them is less than it would be if charges reflected the social cost of road transport. The problems of pricing for road damage are not addressed here, because the distortions created by road rate pricing by the rail sector far outweigh the distortions created by lack of recognition of the external cost of road damage. This can be seen in Table 1.

The Benefits of Abandonment

The resource costs associated with continued operation of the two branch lines were compared with an alternative which involved road transport from branch line sites to Merredin. Regardless of how grain is transported to Merredin, it is carried by standard gauge trans to the port, so this analysis only compares the costs of getting the grain to Merredin. Results are shown in Table 1. It can be seen that after track maintenance costs are taken into account, the costs of operating the branch line services are about double that of the road transport option for both branch lines.

TABLE 1

Annual Costs of Rail and Road Alternatives for Transport of Grain to Merredin Sub-Terminal

	Rail	Road
Trayning Branch Line		
Total Operating $m	0.27	0.32
Road Damage $m		0.06
Track Maintenance $m	0.63	
Total Cost $m	0.89	0.38
Total Saving from Rail Closure		$0.52m
Kondinin Branch Line		
Operating $m	1.33	1.12
Road Damage $m		0.28
Track Maintenance $m	1.21	
Total Cost $m	2.55	1.40
Total Saving from Rail Closure		$1.15m

Author's calculations.

As illustrated in the theoretical model presented above, there is no market mechanism to encourage these efficiency savings to be realised. Transport charges are set equal to the road rate over the entire journey, and road is not competitive over the entire journey. Profits made on the main line service help to subsidise the inefficient branch lines. Road transport operators could only compete for the segment of the journey where they have lower costs, if the price of branch line services were separated from the price of main line services to the port.

The competitiveness of road transport is undermined further by the radial rating system adopted by Westrail. Freight rates are set according to the radial distance from the port, which means that the freight rates are actually lower than the Merredin rate for some branch lines site. The perceived cost of abandoning the branch lines the extra cost that would be transferred to farmers (under the current pricing system) if branch line services were discontinued and grain was delivered by road to Merredin. The perceived cost if the cost of transporting by road to Merredin plus the change in the rail freight rate (the Merredin rate minus the branch line rate). It can be seen that in all cases market signals show that branch line abandonment will increase costs, contrary to the analysis of resource costs presented in Table 2.

TABLE 2

Extra Financial Charges to Farmers if Branch Lines are Abandoned

Rail Freight Rates to Port			Road Rate to Merredin	Extra Charges to Farmers[2]
Branch Line Site	Rate/t	Excess rate for Merredin[1]	$/tonne	$/tonne
Trayning	18.17	-1.35	5.88	7.23
Kununoppin	18.92	-0.6	3.87	4.47
Nungarin	19.44	-0.08	2.95	3.03
Nukarni	19.56	0.04	2.42	2.38
Kondinin	18.59	-0.93	8.45	1.38
Bendering	18.75	-0.77	7.67	8.44
South Kumimin	18.91	-0.61	6.18	6.79
Narembeen	19.34	-0.18	4.94	5.12
Mt Walker	21.14	1.62	7.02	5.40
Wogarl	19.99	0.47	4.36	3.89
Muntadgin	20.25	0.73	3.84	3.11
Holleton	22.29	2.77	7.87	5.10
Koonadgin	20.25	0.73	3.00	2.27

[1] Amount by which rate from Merredin to Port ($19.52/tonne) exceeds the rate from local site to Port.

[2] Extra charges payable by farmers if prevailing rates apply when branch line is abandoned. This charge is the sum of the road rate and the excess rail rate.

Sources: Rail freight rates were obtained from the Western Australian Grain Freight Steering Committee, Road freight rates are figures quoted from a private transport operator.

Conclusion

The benefits of deregulation is encouraging cost savings in grain transport may be limited. This is because the rail industry has a captive monopoly over the part of the transport journey that is adjacent to the port. Even though road transport may be competitive at outlying fringes due to low traffic volumes, all grain must pass through the area over which rail has monopoly pricing power. The bundling of an efficient and inefficient services permits cross subsidisation and over investment in rail infrastructure.

Rail monopolies providing a transport services like the one illustrated in this paper should make a profit if they are operating efficiently. Break-even constraints on regulated monopolies will mean that inefficient low density track will be maintained, resulting in deadweight losses. An example of two inefficient branch lines in Western Australia which cost twice as much as the alternative road transport was shown. Simple observation can also support this finding. The industry has been deregulated for five years, yet these branch lines continue to be maintained. There are no pricing signals in the current system to direct grain flow through the least cost combination of transport modes.

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